Student Edition

California Education and the Environment Initiative

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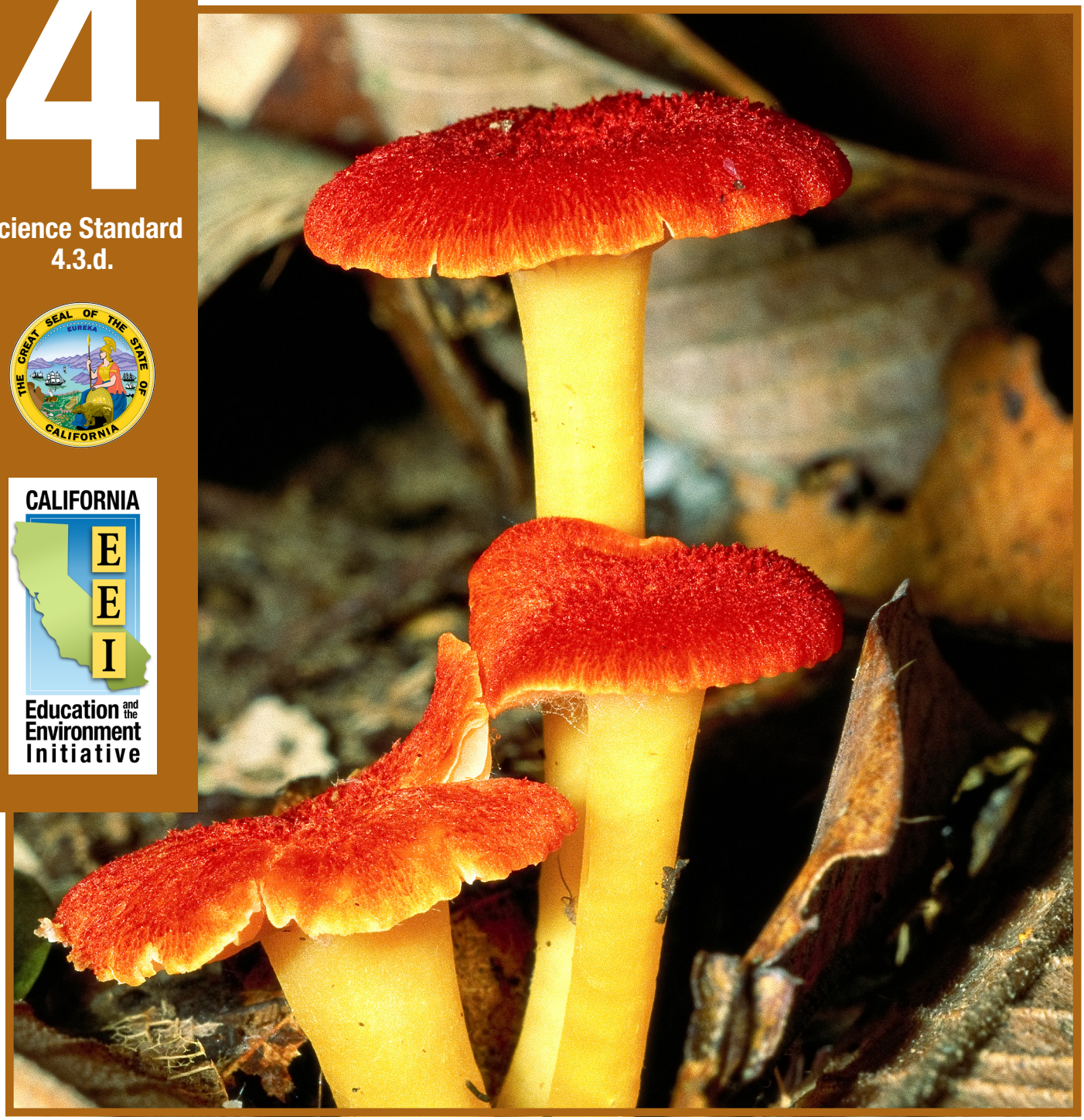

Microorganisms and the Human World

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

The Education and the Environment Curriculum is a cooperative endeavor of the following entities:

California Environmental Protection Agency

California Natural Resources Agency

Office of the Secretary of Education

California State Board of Education

California Department of Education

California Integrated Waste Management Board

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Key Partners:

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Contents

Bacteria

- Bacteria are so small that 1,000 bacteria could fit on the head of a pin.
- Some bacteria have bodies shaped like grapes, hot dogs, or slugs.
- Bacteria have a simple cell structure, without a nucleus.
- Bacteria can break down almost anything, especially dead animals and plants.

Fungi

- Most fungi are too small to see, but some are as big as a football!
- Fungi have a body (mycelium) and thread-like structures (hyphae).
- Fungi come in many shapes and colors.
- Yeasts, molds, and mushrooms are fungi.

Protists

- Most cannot be seen without a microscope.
- Protists live in water.
- Some protists use cilia (look like hair) to move in water.
- Some protists have an irregular shape and look like “blobs” full of water. They can change shape as they move.

San Francisco Sourdough

Have you ever been to San Francisco? If you have, you may have tasted the special bread that is made in this city by the bay. It is called sourdough bread. The first thing you will notice is that this bread is toasty brown. It smells so good; you will want to try it right away!

Your first bite may surprise you. The crust is thick and chewy. Sourdough tastes like it has a tiny bit of lemon flavor mixed in. Guess what? There is no lemon in it! You will also notice how light and soft it is inside.

Microorganisms and Sourdough Bread

To understand what makes sourdough bread light and sour at the same time, we need to understand what yeast is. Yeast is a microorganism with only one cell. It lives together with other yeast cells in a sort of colony or community. Yeast "eats" sugars or starches (like flour) to grow. Wild yeast is everywhere. It lives in

San Francisco Ferry Building

the air all around us. You can buy fresh yeast in cakes or dry packaged yeast from the store. Packaged yeast is used to make most breads and bakery products. Carefully selected yeast and special bacteria are used to make sourdough bread.

When the yeast digests sugar or starch, it makes carbon dioxide and alcohol. The bacteria produce lactic acid, which gives sourdough its sour taste. The carbon dioxide gas given off by the yeast puffs up the dough, and sometimes leaves big holes in it when the bread is baked. This makes the bread light and delicious! You can see the carbon dioxide bubbling up when you mix yeast with flour and water.

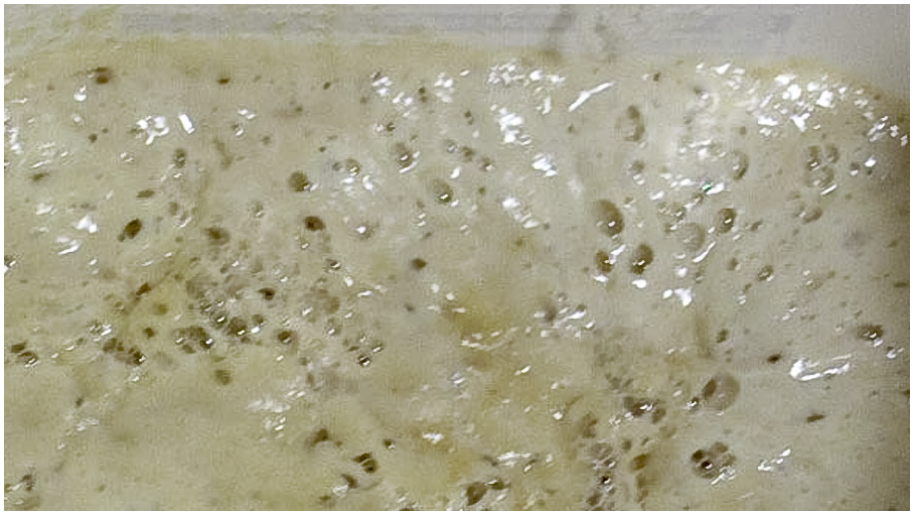
The yeast and bacteria live together. You could say that these partners enjoy a symbiotic relationship. They help each other by keeping out bacteria that do not belong in the bread.

Sourdough bread

The unwanted bacteria might make the bread taste funny. These organisms keep sourdough bread fresh for a longer time. They make the bread soft inside and give it a good smell and a tangy taste. Without the work of yeast and bacteria, there would be no sourdough.

Real sourdough bread is completely natural. There are no chemicals added to make the dough rise faster, taste better, or last longer. The ingredients are very simple. You begin with flour, water, and salt. Then you add "sourdough starter." Sourdough starter is made from flour and water, too. The starter is left in a warm place for a few days before it is ready to use. Wild yeast and bacteria in the air fall into the batter. The bacteria help the yeast digest the sugar and starch in the flour. You could say that the yeast "eats" the starch in the flour and "breathes" into the dough. Your starter is now alive!

After the starter sits for a few days, it will begin to



Sourdough starter

smell a little sour. Once a starter is ready, it must be "fed" to stay alive. More flour and water should be added every few weeks. Sourdough starters can be used for over 50 years. All you have to do is add a little starter when making the next loaf of bread you bake.

Temperature, weather, and the time the bread rises are also important. Sourdough can be made with white, wheat, rye, or other kinds of flour. The type of flour makes a difference in the taste of the bread. The kinds of yeast and bacteria in the bread may also change its flavor. Sourdough bread does not have to be sour. It may have a mild, yeasty flavor, depending on the recipe and starter used.

Sourdough Bread: A Food for Many People

Sourdough bread has a long history on Earth. People baked this type of bread in Egypt over 6,000 years ago. Scientists think that sourdough baking got started when yeast and bacteria found their way into someone's bread dough by mistake. The people must have been surprised when their bread was so light and a little sour! The Egyptians liked it so much that sourdough bread was

San Francisco wharf

even found in the ancient tombs of their kings.

California has a sourdough history, too. Miners made sourdough bread in their camps during the northern California Gold Rush. In 1849, fresh yeast was hard to find and spoiled quickly. It was important that the bread they made could rise without "fresh" or store bought, yeast. To make the sourdough starter, all the miners had to do was to put some flour and water together with a little sugar. Then they left the starter outside and let the wild yeast and bacteria do the work. The starter was ready for making bread in just a few days.

When miners returned to the gold fields, they took their sourdough starter with them in a small leather bag. The miners stored it near the campfire to keep it warm. They "fed" it each week with more flour and water. There are stories of miners in Alaska that even slept with their starter. They wanted to keep it from freezing on cold winter nights! Miners in California and Alaska were called "sourdoughs" because they baked the special bread wherever they went.

Bread dough

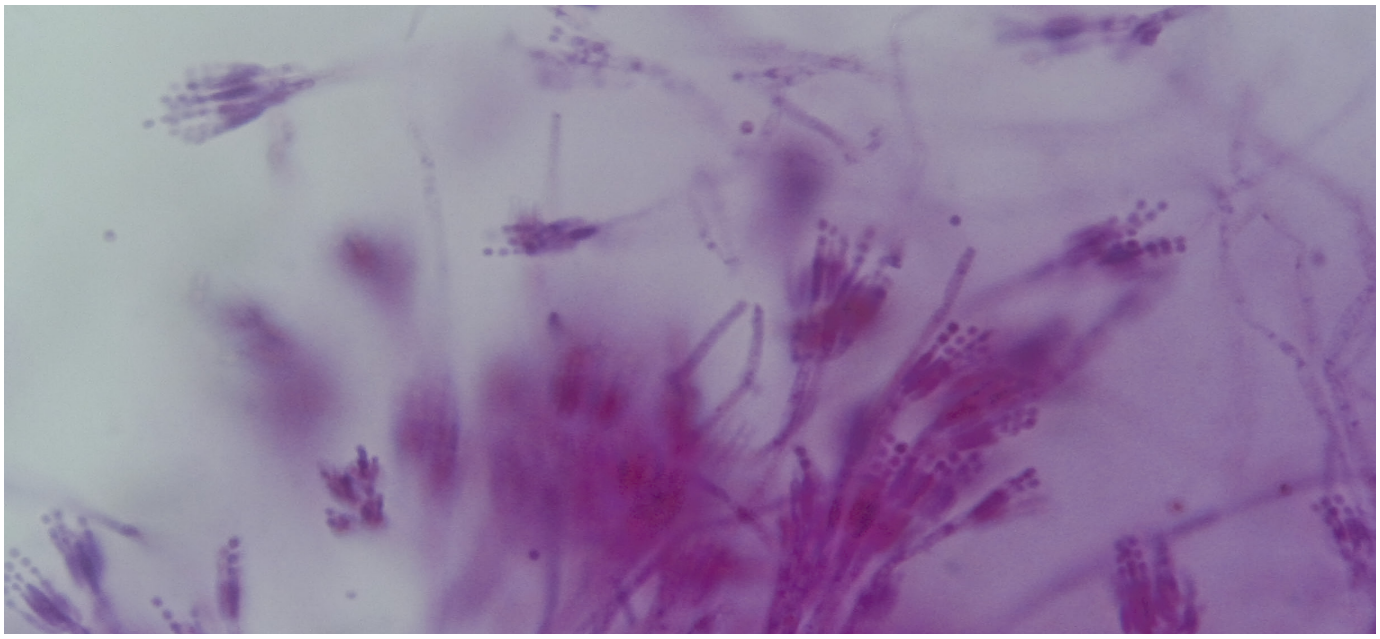
The wild yeast and bacteria in the air worked together in the starter. Soon, the starter would start to bubble. This was called a "sponge." Miners then added more flour, water, and salt to make bread dough. They kneaded and punched the dough and left it to rise. This took a few more hours than regular bread. The dough was then ready to bake into a thick crusty loaf. The miners baked their bread over the campfire in large iron pots. They put hot coals on top. The bread was delicious. It lasted for many days if the miners did not eat all of it at one meal!

The miners came down from the mountains to celebrate when they had enough gold in their

pockets. They traveled all the way back to their favorite city. San Francisco turned out to be the perfect place to make sourdough bread. A French baker named Isidore Boudin opened a tiny bakery there in 1849. He tried baking his French-style bread with sourdough starter. The miners would go to Boudin's Bakery every morning for coffee and some of his delicious bread. During the Great San Francisco Earthquake, Boudin's widow, Louise, saved his famous sourdough starter. She called it the "mother dough."

Today, San Francisco is still famous for its sourdough. Many tourists and people who live in the city visit the bakeries along the wharf and around the city. Tourists come from all over the world to try the delicious bread. There is nothing else like it. The scientist who discovered the bacteria that make the bread taste so good named it *Lactobacillus sanfranciscoensis*, after the city. He found that the microorganisms only grew in towns that were fifty (or less) miles from San Francisco. Sourdough bakeries found a way to package their special bacteria/yeast mix. Now people can enjoy San Francisco sourdough wherever they are!

Sourdough bread



Close-up of *Penicillium* bacteria

History of Antibiotics

What are Antibiotics?

Your friend develops a high fever. She has to go home from school. The doctor says your friend has scarlet fever, a disease caused by a very harmful bacterium. She is very sick.

If this happened in 1900, your friend could have died. Now, your friend can go to the doctor. Taking an antibiotic will help her get better.

Antibiotics kill bacteria. Sometimes they just stop bacteria from growing. You may have used an antibiotic cream. These creams help heal cuts and scrapes. Your doctor gave you antibiotics to help you get over a fever or an ear infection. Antibiotics have often been called "miracle drugs." This is because they work well against so many infections. Diseases that used to kill people can now be cured by taking antibiotics.

The Discovery of Penicillin

Sir Alexander Fleming was a famous scientist. He lived in Scotland during World War I. He took care of injured soldiers. He saw many of them die from infected wounds. He wanted to find a way to kill the bacteria that caused infections.

In 1928, Sir Fleming was trying to learn how infections happen. He grew bacteria in small dishes. One day, he noticed a mold growing in one of the dishes. The mold had crust in the shape of a circle. Sir Fleming saw that the bacteria around the crust had died. He began to study this mold to see what killed the bacteria. Sir Fleming discovered that the mold made a chemical to protect it from bacteria.

Sir Fleming and other scientists continued to study this mold. They called what the mold made to kill the bacteria "penicillin." Penicillin saved the lives of many soldiers during World War II. Since then, penicillin and other antibiotics have saved millions of human lives.

Alexander Fleming studying penicillin

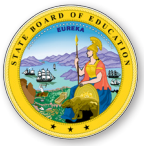
Penicillin in Action

Have you ever heard of pneumonia? Pneumonia happens when bacteria infect the lungs. It makes the lungs fill up with liquid instead of air. It makes people very sick. Before doctors had penicillin, about half the people sick with pneumonia died. Today, pneumonia is treated with penicillin or other antibiotics. The antibiotics kill the bacteria.

Antibiotics with "cillin" in their name are made with penicillin. Some are liquid and some are powder. You swallow or drink the antibiotic. Sometimes it is injected so it can work faster and have fewer effects on the "good bacteria" in your intestines. Once in the body, it starts to kill the bacteria.

Antibiotics mainly help with diseases caused by bacteria. Doctors should only give antibiotics when an infection is caused by bacteria or other organisms that can be controlled by the antibiotic.

Only take medicine when the doctor or your parents tell you to take it.



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